

CHAPTER 7. RESPONSES TO INCIDENTS OF HOME CONTAMINATION

CHAPTER SUMMARY

In this Chapter, responses of Federal and State agencies and industry to incidents of workers' home contamination are reviewed. NIOSH found that several Federal agencies have responded to incidents of workers' home contamination, often working together or working with State or local governmental agencies. These responses by Federal agencies have resulted in identification of workers' home contamination that otherwise would have not have been known, decontamination of workers' homes and recommendations for instituting workplace changes that would prevent further contamination. In several cases, Federal agencies have referred incidents to State or local health departments for follow-up actions.

A number of State agencies have also investigated incidents of workers' home contamination, made referrals to Federal agencies for follow-up actions and made recommendations for workplace improvements to prevent further contamination of workers' homes.

In some instances where States reported they had no information on home contamination investigations or incidents, such reports were found in the literature. Likewise, for some States that did not respond to inquiries, reports were found in the literature of investigations that took place in the State. Often, in these instances, the investigations were conducted by local health departments collaborating with Federal agencies and reported in journal articles or CDC's Morbidity and Mortality Weekly Report (MMWR).

Only a few responses of industry to incidents of workers' home contamination were found. However, these reports indicate how industry can contribute to prevention by informing workers of hazards, as well as by taking specific actions to correct situations where workers' families are at risk or by use of preventive measures.

RESPONSES OF FEDERAL AGENCIES

In this section, responses of Federal agencies to incidents of workers' home contamination are reviewed. The information for this section, compiled in Table 19, was derived from published reports and responses to requests for information by NIOSH.

OVERVIEW

Agencies that have responded to incidents of workers' home contamination include: (1) the Centers for Disease Control and Prevention (especially the National Center for Environmental Health and the National Institute for Occupational Safety and Health); (2) the Occupational Safety and Health Administration; (3) the Mine Safety and Health Administration; (4) the Department of Energy; (5) the Environmental Protection Agency; (6) and the Agency for Toxic Substances and Disease Registry. In many cases, Federal, State, and local agencies collaborated on the investigations. In all

of the incidents in which OSHA was involved, State or local health departments were also involved by either notifying OSHA of probable home-contamination cases or by being informed by OSHA of such cases. Several of the investigations conducted by CDC and ATSDR have also been in collaboration with agencies of State or local governments. These Federal agency investigations and responses to incidents of workers' home contamination have resulted in:

- Recommendations for instituting changes in industrial hygiene practices to prevent further home contamination.
- Decontamination of workers' homes.
- Identification of workers' family members who have been exposed to or poisoned by toxic substances introduced into the home from the workplace.

Centers for Disease Control and Prevention (CDC)

The Centers for Disease Control and Prevention has conducted about 20 studies on incidents of workers' home contamination; about half of these have been conducted by NIOSH, and the rest by other Centers, especially the National Center for Environmental Health. NIOSH has further identified potential for workers' home contamination in a number of its evaluations of individual workplaces and made recommendations for improved industrial hygiene measures for its prevention. CDC has also presented information to Congress on issues of home contamination and published reviews to assist professionals that may be confronted by cases of workers' home contamination and resulting family poisonings.

National Center for Environmental Health (NCEH)

The mission of NCEH is to prevent and control disease and disability related to the interactions between people and their environment outside of the workplace. The Center's applied research has evaluated incidents of workers' home contamination by lead, pesticides, arsenic, tin, and PCBs.

Lead. Three studies [Baker et al. 1977; Landrigan and Baker 1981; Matte et al. 1991] were conducted by NCEH on families of lead smelters workers. These studies found that homes of exposed workers had higher concentrations of lead than controls and that family members BLLs were elevated. Following the study by Baker et al. [1977] the homes were cleaned and workers showered and changed clothes before going home.

Families living in contaminated homes of battery plant workers were found to have elevated BLLs in four studies [Watson et al. 1978; Dolcourt et al. 1978; Dolcourt et al. 1981; Matte et al. 1989]. Following the studies by Dolcourt et al. [1984], home decontamination was undertaken.

Kaye et al. [1987] found elevated BLLs among children of workers exposed to lead in a plant manufacturing electrical components and made recommendations for taking preventive measures in the workplace.

Novotny et al. [1987] studied the BLLs of firing range workers and their spouses, finding elevated levels in the workers but not in the spouses.

In an ongoing study of workers exposed on the firing range of the FBI Academy, the workers' vehicles have been found to be contaminated with lead; however, lead dust levels in the workers' homes and BLLs among the workers' children were low, suggesting that the children were not being exposed to significant amounts of lead [Briss 1994].

In March, 1993 NCEH and NIOSH collaborated on an exposure assessment for heavy metals associated with a smelter in Oruro, Bolivia. The investigators evaluated biological and environmental samples for lead, arsenic, antimony, and tin. Both environmental testing and biological monitoring suggested that workers' homes were contaminated by tin. However, the biological results were not elevated to levels documented to cause adverse health effects [Briss 1994].

Other. In a study of a community that had used sludge contaminated with PCBs, Baker et al. [1980] found higher levels of PCBs in the blood of family members of sewage treatment workers than in other members of the community.

Falk et al. [1981] reported on a case of angiosarcoma in a young girl whose father worked with arsenic and wore contaminated clothing home.

Wolfe et al. [1961] studied cases of pesticide poisoning in children and made recommendations for pesticide applicators that included decontamination of empty drums and clothing.

A joint study by CDC and EPA [Canon et al. 1978], found that wives of workers' exposed to kepone had signs of kepone poisoning. These women had washed their husbands' clothes.

National Institute for Occupational Safety and Health (NIOSH)

NIOSH conducts evaluations of health hazards in the workplace. About 40 NIOSH studies have addressed potential or actual incidents of workers' home contamination.

Asbestos. Five investigations of potential workers' home contamination by asbestos were reported by NIOSH. These investigations were made at: a construction site [Lemen 1972]; a plant manufacturing flooring material [Belanger et al. 1979]; a plant manufacturing friction products [Seixas and Ordin 1986]; a chemical plant [Driscoll and Elliott 1990] and a brake-service facility [Godby et al.

1987]. In each case it was determined that the potential existed for workers to bring asbestos home on their clothing as a result of inadequate or inconsistently applied industrial hygiene practices. In two cases [Seixas and Ordin 1986; Driscoll and Elliott 1990], asbestos was detected on the workers' clothes as they left the worksite. In an evaluation of a construction site [Lemen 1972] and a brake-service facility [Godby et al. 1987], NIOSH found that most workers did not change clothes before leaving work and that their work clothes were laundered at home. In all of these studies, recommendations were made that would prevent workers' home contaminations such as reducing exposures at work and leaving contaminated clothing at work.

Lead. Five investigations of exposure of workers to lead and potential home contamination were reported by NIOSH: stained glass manufacturing [Landrigan et al. 1980]; battery manufacturing and recycling facilities [Apol and Singal 1980; Matte and Burr 1989; Gittleman et al. 1991]; tank lining [McCammon et al. 1991; CDC 1992a]; gold assaying [Gunter et al. 1987]; and building renovation [Kiefer 1994]. In a study by Matte and Burr [1989] of back-yard battery repair shops, contamination of the homes and elevated BLLs of family members were found. Elevated BLLs of stained-glass workers' families were related to occupational exposures of the worker [Landrigan et al. 1980]. Lead was detected in workers' cars by McCammon et al. [1991], indicating a potential for transfer to the home. In these reports, improved hygiene practices were recommended to prevent contamination of homes.

Pesticides. Kominsky [1984c] studied the contamination of firefighters protective clothing by malathion and diazinon following a fire and made recommendations for laundering the contaminated clothing.

Chlorinated Hydrocarbons. Investigations of two cases involving PCBs, one a manufacturing plant and one a railroad yard, resulted in industrial hygiene recommendations to prevent transportation of the contaminant from the workplace [Hartle et al. 1987; Hartle 1987]. Several studies addressed instances in which firefighters' clothing was contaminated with PCBs [Kominsky 1984a, 1984b, 1987a, 1987b; Kominsky and Singal 1987; Orris and Kominsky 1984; Seligman 1984]. The reports provided recommendations for laundering clothing and using protective clothing.

Mercury. During the health hazard evaluation of a thermometer plant in Vermont, the NIOSH trailer where workers received medical tests became contaminated with mercury, suggesting that contamination of the workers' homes with mercury was possible [Ehrenberg 1986]. Since the plant was closed soon after the study, industrial hygiene recommendations were not included in the report.

Estrogenic Substances. Children of chemical-plant workers who contaminated their homes had enlarged breasts due to zeranol, an estrogenic animal growth

promoter. Zeranol was brought home on contaminated work clothing. NIOSH made recommendations to prevent home contamination [Aw et al. 1985]. NIOSH also participated in a study on poisoning of farm children by diethylstilbestrol [Bierbaum 1993].

Agency for Toxic Substances and Disease Registry (ATSDR)

The Agency for Toxic Substances and Disease registry has conducted several studies of hazardous waste sites that are relevant to workers' home contamination. An investigation of a chemical manufacturer in Adrian, Michigan showed detectable levels of MOCA in the urine of workers' families. The workers' homes were contaminated [ATSDR 1989a, 1990b, 1993b] by MOCA that may have been tracked out of the workplace on the employees' clothing and shoes. The homes were decontaminated.

An investigation at the Bofors-Nobel, Inc. Company in Michigan found 3,3'-dichlorobenzidene contamination in workers' homes and 3,3'-dichlorobenzidene in the urine of some workers and family members [ATSDR 1991b].

Other ATSDR reports describe investigations of contamination by MOCA [ATSDR 1989b], lead [ATSDR 1991a], and mercury [ATSDR 1990a]. In other cases, attempts by ATSDR to evaluate workers' home contamination failed because of inadequate participation by workers' families [ATSDR 1993a, Alabama Department of Public Health 1991].

Occupational Safety and Health Administration (OSHA)

Although in general OSHA's jurisdiction is limited to the workplace, through interactions with State and local health departments some reports on workers' home contamination have resulted from its investigations. In addition, a recent review article [McDiarmid and Weaver 1993] addresses issues of poor industrial hygiene, cottage industries, and physician awareness as they relate to workers' home contamination.

[Natarajan 1994] described an OSHA investigation of a workplace in Texas after learning of high BLLs in a child. The child's father (who also had an elevated blood lead level) worked as a radiator repairman. Recommendations were made to prevent further contamination.

The local health department in Kankakee, Illinois referred a case to OSHA of gross lead contamination of a home [Wiehrdt 1994]. Two children were hospitalized and chelated for lead poisoning. OSHA conducted a comprehensive inspection of the battery plant where the father worked and found that he was bringing lead home on his clothing.

OSHA suspected a potential home contamination problem while inspecting a local plant in 1984 in Indianapolis, Indiana and referred the potential problem to the

county health department [Wiehrdt 1994]. Subsequent investigation by the county health department determined that at least one of the children had a BLL of 50 $\mu\text{g}/\text{dL}$.

In 1990, the Cleveland area OSHA office investigated a company where it was determined that employees were being exposed to lead [Wiehrdt 1994]. Learning of three employees whose children had elevated BLLs, OSHA conducted sampling in the employees' homes. Later, the case was reported to the Ohio Department of Health and the Cleveland Lead Hazard Abatement Center.

Mine Safety and Health Administration (MSHA)

MSHA has investigated two instances where workers inadvertently brought mercury into their homes and cars [Zalesek 1994]. In one case, the workers' washers and dryers were the most heavily contaminated part of the homes. The company cleaned the homes.

Environmental Protection Agency (EPA)

The Environmental Protection Agency investigated, and decontaminated homes of workers contaminated by mercury in Tennessee [ERM-Southeast, Inc. 1989]. In another study supported by EPA, PCB contamination of workers' homes was documented [Price and Welch 1972]. EPA has also conducted various investigations and remedial activities on homes contaminated by: dioxin [Ramsey 1987; MacDonald 1988; Doherty 1984; Hess 1988]; lead [Beegle and Forslund 1990; CH₂M Hill 1991]; and asbestos [Beegle and Forslund 1990]. Although these latter reports are not about homes contaminated by workers' activities, they do provide protocols and information relevant to cleaning contaminated homes of workers.

Department of Energy (DOE)

Beginning in October 1990, the Department of Energy (DOE), under DOE order 5000.3A, required the reporting of any event which could "affect the health and safety of the public, seriously impact the intended purpose of DOE facilities, have a noticeable adverse effect on the environment, or endanger the health and safety of workers." In February 1992, this order was superseded by DOE order 5000.3B, with some modifications in reporting criteria. The requirements cover "events" related to radioactive as well as other hazardous materials and replaced a previous "unusual occurrence reporting system" instituted in 1984. The central DOE operational database containing all post-1989 occurrence reports is called ORPS (Occurrence Reporting and Processing System) and is maintained by the DOE Office of Nuclear Safety. There is no central repository of pre-1989 records or reports [Boyle 1994].

Both chemical and radiologic contamination incidents are covered by the DOE reporting policy. The database is not classified; if any of the reports involve classified information, a computer entry notes that there is a classified report, with the detailed description maintained in a classified hard copy file. The reported

incidents are summarized weekly in a publication prepared by the Nuclear Safety Office of DOE.

There are approximately 19,000 reports from 1990-present in the database. Since off-site contamination of a home is not uniquely coded; the use of word searches with ORPS can lead to under-counting of relevant cases of potential take-home contamination. In addition, there may be reports of workers' home contamination in the pre-1990 files which were not searched.

The ORPS Program Manager provided 16 reports related to contamination of workers' homes with hazardous substances transported from the workplace [Boyle 1994]. These reports primarily describe breaks in procedure or poor work practices with potential rather than actual take-home contamination, or with take-home activity that did not result in contamination of the workers' homes or family members. The three incidents involving possible contamination of workers' homes or family members include:

- Workers contaminated with thorium and protactinium while changing valves on cylinders, apparently ignored positive readings on contamination monitors, resulting in contamination of one employee's pillow case and shirt and another employee's shoe. The incident led to major revisions in the facility's monitoring program and contamination control procedures. Based on survey information and monitoring data, which indicated no internal contamination of the workers and "minute" external (skin) contamination, the incident was anticipated to have "negligible effect on the health of the workers or the public."
- An employee was found to have contaminated hands when monitored upon entering the facility; the employee had not gone through the monitoring process when exiting from work the previous night. Survey of the employee's home found that two items of personal clothing worn the previous day were contaminated. Levels of contamination were "extremely low" and there was felt to be no exposure to the employee's family. The employee and his clothes were decontaminated and the employee was terminated for "willful and flagrant disregard of health and safety procedures."
- Initially-undetected damage to an americium source resulted in contamination of a worker's hat, which was found on a routine survey several days after the event. A follow-up investigation identified americium on the diaper of a worker's infant child. A panel of independent experts from the national radiation dosimetry community, the radiological medicine community, and a local pediatrician guided the follow-up evaluation. The panel concluded, the most likely explanation was that this was a false positive because of poor laboratory performance. The poor laboratory performance was well-documented by the evaluators and no subsequent samples were sent to this laboratory. The team reviewing the incident

recommended more careful handling of and administrative controls for americium sources.

Nuclear Regulatory Commission (NRC)

NRC did not report cases of Agency responses to incidents of workers' home contamination. However, it has established reporting requirements that identified cases of potential home contamination and responses of employers involved. The U.S. Nuclear Regulatory Commission has regulatory jurisdiction over byproduct material of reactors plus "special nuclear material" used as reactor fuels or bomb material. Users of radioactive materials falling under NRC jurisdiction include commercial nuclear power plants, university and hospital laboratories using radioactive materials, and industrial users of radiation sources. Twenty-nine States have agreements with NRC delegating to the States regulation of nuclear materials within their borders; NRC directly administers regulatory activities in the remaining 21 States.

Reporting regulations contained in 10 CFR 20 are intended to cover all significant incidents of off-site contamination, including contamination by radioactive material accidentally or intentionally brought home by workers.

NRC maintains two databases potentially containing reports of off-site contamination of workers' homes: the database of events called in to the NRC Operations Center (dealing mostly with reactor-related events) and the Non-Reactors Event Reporting (NRER) database, which is a compilation of significant Non-Reactor licensee reports that were originally sent to the NRC regions [Brockman 1993].

At the request of NIOSH, NRC personnel searched these two databases to identify events involving radioactive contamination brought home from the workplace. A search of NRC Operations Center data from 1985 to mid-September 1993 identified 34 incidents of off-site contamination; in seven of these, the brief reports directly address the possibility for take-home radioactive material.

- Contaminated hand tools were found in the home of a nuclear power reactor contractor's home. One tool was radioactive, but no personnel or items in the contractor's home were contaminated.
- A deliberate ingestion of uranium acetate was associated with contamination of the ingester's home.
- Four nuclear power plant contract workers contaminated their socks and shoes, which went initially undetected by monitor with potential contamination of a home and a hotel.
- Low-level contamination, initially undetected at a portal monitor, was discovered on clothing brought home by a power reactor worker.

- A worker in a fuel cycle facility was burned by a radioactive acid solution. Although no contamination was discovered during the worker's self-frisk before he was transported to the hospital, external contamination was subsequently detected on the acid burn areas.
- Low-level contamination was found on the accelerator pedal of a worker's vehicle during employee screening after detection of P-32 contamination in a laboratory.
- Four contract workers set off portal monitors when reporting to work at a nuclear power reactor for the first time.

No additional information is available for any of these reports.

A search of 1985-92 NRER data identified 80 contamination events resulting in off-site contamination. The reports generally lack detail, but those which raise the possibility of take-home contamination include:

- In the 1970s, in accordance with his employer's policy at the time, a worker used waste lumber from his workplace to construct a garage in his home. The employer manufactured catalysts containing depleted uranium. In 1991, following newspaper articles concerning radioactive contamination at the site, the employee contacted the State department of health. Surveys of the garage revealed contamination in excess of the NRC release criteria. The licensee replaced the garage. There were no reports of adverse health effects.
- Phosphorus P-32 was spilled in a university laboratory over a weekend; the spill was discovered when contamination was found on an individual's shoes. Contamination was found in the laboratory, in the building outside the laboratory, in at least one automobile, and on the shoes of about 40 individuals. Contaminated areas were isolated and cleaned up and all contaminated items were impounded and decontaminated. There were no reports of adverse health effects.
- A contamination event at a hospital resulted in contamination of a pharmacy truck driver, his truck, and a transport box. No additional information available.
- Radioactive sand from a Federal facility was disposed of in a septic tank on a farm. No additional information available.
- "Small areas of contamination" were found in a worker's residence. No additional information available.
- Contamination found at a residence recently vacated by the owner of a licensed laboratory. No additional information available.

RESPONSES OF STATE AGENCIES

Information on State agency investigations into incidents of home contamination was obtained in two ways. The first was by direct solicitation of various State agencies, including State agriculture and State and local health departments, State departments of labor, and State environmental departments. Responses received from these State agencies are compiled in Tables 20 and 21. The second way documentation of State investigations was obtained was through literature searches in the open literature. Studies by State agencies identified in this way are compiled in Table 22.

The reports of the State agency responses to, or investigations of, home contamination incidents are discussed by groups: Lead; Pesticides; and Other.

Lead

Because of its wide use in a number of common industries, and particularly because of its serious neurological impact on children, the most commonly cited incidents of home contamination from the States involve lead. Many States maintain active surveillance of lead poisoning through local health departments and physician reporting and as a result can identify incidents for investigation.

In California, laboratories that analyze blood for lead content are required to report BLLs of 25 $\mu\text{g}/\text{dL}$ or above to the California Department of Health Services and to the local county health department [Osorio 1994]. Programs in the California Department of Health Services, the Occupational Lead Poisoning Prevention Program and the Childhood Lead Poisoning Prevention Branch, coordinate investigations of elevated BLLs with local health departments. Take-home exposure cases are typically identified during the investigation of workers with high BLLs or follow-up of childhood cases where lead exposure is identified in the job of a parent or other household member. In terms of prevention activities, the Occupational Lead Poisoning Prevention Program includes information on take-home lead exposure in their outreach and educational efforts. Data from the Childhood Lead Poisoning Prevention Branch show that of the 1,232 cases of elevated BLLs in children under age 16 with follow-up information, 106 had a potential exposure in a worker's contaminated home. Of those with information reported about the lead workers in the household, 33% changed clothes before leaving work, 13% took showers before going home, and only 18% ever had a blood lead test for work.

The California Department of Health Services provided five case studies of take-home lead exposure in response to the NIOSH Federal Register request for information [Osorio 1994]. Industries involved in these cases include: lead recycler/bullet manufacturing; radiator repair; and cable cutting operations.

In the cable cutting operations case, the county health department conducted a follow up investigation of a 3-year-old child with a BLL of 28 $\mu\text{g}/\text{dL}$ whose uncle, a lead cable cutter, for 4-5 years lived with the family. The father was also employed in this trade for 3 months prior to the investigation. Their employer did not provide

hand washing or showering facilities at the worksite. Work clothing was laundered at home, and a lead concentration of 1,700 ppm was found in a composite sample of dust in the home. In addition, the home's back yard was contaminated with lead from lead contaminated telephone poles which were brought from the worksite and stored in the back yard for firewood. The State industrial hygienist recommended and the company complied with the following preventive measures:

- test all workers blood lead levels;
- provide a medical monitoring program;
- provide a testing facility;
- provide protective clothing;
- provide worker training;
- provide an air monitoring program; and
- implement safe clean-up methods.

The Minnesota Department of Health investigated the potential for elevated blood lead levels among household contacts of employees of a lead smelter [Winegar et al. 1977]. Data gathered as a result of this study showed high levels of lead in the workers' clothing and hair and elevated blood lead levels in some children of the workers. This smelter reclaimed lead from old batteries. Home contamination incidents from similar battery manufacturing, recycling, or reclamation operations were investigated by health departments in several States:

- In a Tennessee case investigated by the State's Department of Public Health and the local county health department, 49% of the battery reclamation workers' children (50 of 102) had elevated BLLs equal to or greater than 30 $\mu\text{g}/\text{dL}$ [CDC 1976]. The source for lead appeared to be the parents' contaminated clothing.
- Oklahoma investigators found similar results in an investigation of BLLs in children of battery manufacturing workers [Morton et al. 1982].
- In North Carolina, 72% of the children of battery plant workers had BLLs of 30 $\mu\text{g}/\text{dL}$ or above [CDC 1977b].
- An investigation by the Alabama Department of Health in 1991 of a battery recycling operation revealed elevated BLLs in most of the workers. When the

local county health department measured the BLLs of the children of these workers, mean BLLs were 22.4 $\mu\text{g}/\text{dL}$ [CDC 1992b].

These investigations resulted in chelation therapy for some victims, recommendations for improved hygiene practices, improved engineering controls, and, in one case, a court order to remove all workers from the workplace.

Reports of elevated BLLs in children of radiator repair workers include:

- The New York City Department of Health found that three of seven radiator repair workers' children had BLLs at or above 10 $\mu\text{g}/\text{dL}$; recommendations for industrial hygiene consultation were made and on-site educational programs were undertaken [Nunez et al. 1993];
- The Minnesota Department of Health investigated BLLs in radiator repair workers and their children and identified the need for worker education, safer work practices, better shop design, and better ventilation in the industry [Lussenhop et al. 1989];

Other cases investigated by States where elevated BLLs in children were attributed to the parents' occupation include:

- A Mississippi Department of Health investigation into lead contamination of a workers' home and made recommendations for changing shoes and clothes before entering the home, washing clothing separately, and cleaning the home [Pollock 1994];
- A capacitor and resistor plant in Colorado was investigated by a local health department and OSHA, finding workers and children with elevated BLLs resulted in enforcement of the OSHA lead standard to reduce exposures of the workers and their families [CDC 1985];
- A local health department in Colorado investigated a belt buckle, plaques, and awards manufacturer and assisted the company in reducing exposure of workers and their families to lead [CDC 1989b];
- The Iowa Bureau of Labor investigated a soil nutrient manufacturer whose raw material contained lead [Hooper 1991]. The employees were not required to shower or change clothes before leaving work. One workers' child was "tested for lead poisoning, the probable cause was washing work clothes with the child's clothes. Actions were taken to remedy the problem; and
- A welder in Indiana whose family car was contaminated with lead and whose child had seizures was reported by the State's Department of Labor [Molovich

1991]. Action taken to prevent further contamination of the home included washing the worker's car once per week and the company laundered his socks.

The New Jersey Department of Health [Stanbury 1994; Czachur et al. 1995] conducted a pilot study of home contamination by lead in 1992. Elevated BLLs ($> 40 \mu\text{g}/\text{dL}$) were identified in 98 persons through the State's occupational lead registry and 45 were contacted, interviewed about their occupations and age of their homes, and offered free blood lead testing for their children. BLLs were obtained on 28 children from the families of 15 of these workers. Nine (32%) of these children had BLLs considered to be a potential risk for adverse health effects ($> 10 \mu\text{g}/\text{dL}$). The parents brought their work clothes home for laundering. Of six children whose parents did not bring their clothes home to be laundered, none had BLLs at $10 \mu\text{g}/\text{dL}$ or above.

Pesticides

Agricultural extension services in Arkansas [Lavy 1988; Huitink 1994], Florida [Anonymous 1994], Iowa [Stone and Wintersteen 1988], Louisiana [Finley et al. no date], Michigan [Branson and Henry 1982], and Nebraska [Easley et al. 1981a; Laughlin and Gold 1989c] have developed informational materials for farmers that advise on preventive measures. These advisories include:

- training courses for pesticide safety;
- brochures describing safe application practices;
- brochures on proper laundering techniques for clothes worn during application; and
- brochures on proper disposal of pesticides containers.

Other

A 1936 study by the Pennsylvania Department of Labor and Industry on the effects of hexachloronaphthalene and chlorodiphenyl (PCB) exposure of wire insulation workers attributed dermatitis in a young child to exposure from his father bringing home contaminated work clothes [Fulton and Matthew 1936].

Hardy [1948] (a physician with the Massachusetts Department of Labor), in a published paper on beryllium exposure and disease, cited a case of beryllium disease in the mother of a beryllium worker. The suspected source of beryllium was exposure to her daughter's contaminated clothes. In the 1960's, cases of beryllosis among workers' family members were investigated by the Pennsylvania Department of Health [Lieben and Williams 1969].

A study published in 1978 by researchers with the New York Department of Health showed a correlation between mesothelioma in women and asbestos related employment of husbands and fathers [Vianna and Polan 1978].

Investigators from the Vermont State Department of Health studied home contamination and health effects in children of thermometer plant workers exposed to mercury [Hudson et al. 1985].

In California, the State Department of Public Health investigated mercury exposure and poisoning of cinnabar miners and mill workers [West and Lim 1968] and developed a document on how to prevent mercury poisoning [Anonymous 1968]. Although the investigators [West and Lim 1968] noted that home contamination with mercury brought home on workers' boots and clothes could increase workers' exposure to mercury, no mention was made of potential exposure of family members.

RESPONSES OF INDUSTRY

NIOSH has attained little information on how industry has responded to incidents of workers' home contamination. This section describes information from NIOSH studies (primarily those that were requested by employers) and from other reports, articles, and submissions by industry in response to the Federal Register Announcement requesting information (Appendix 2). They are tabulated in Table 23.

In a study requested by the owner of a stained glass studio attached to her home, NIOSH investigators determined that the exemplary industrial hygiene and housekeeping practices in use were adequate, since no lead was detected in the home [Donovan 1994a,b]. The owner requested the study because of concerns about exposures both in the home and the workplace.

In the case of a mercury thermometer plant where children of the workers were found to have been exposed to mercury, the plant voluntarily closed [Hudson et al. 1987]. Part of the plant re-opened when appropriate controls had been implemented. Another example of industry response occurred when an employee of a wood treating company brought home and spilled chloropicrin from a company truck, which made neighbors ill, and the company instituted a policy forbidding bringing company vehicles home [Barnett 1994].

Examples of educational material produced by industry (or their associations or trade magazines) involve lead. The Lead Industries Association, Inc. has produced brochures, flyers, and videotapes that warn of the dangers of lead exposure and provide advice on how to reduce these exposures and prevent workers' home contamination [LIA 1989; 1991; 1993a,b; 1994a,b]. Several of the videotapes are specific to particular hobbies or industries that involve the use of lead containing material. *Battery Man*, a trade magazine, published an article on protecting the families of workers involved in battery production [Lundquist 1980].

CHAPTER 8 - RECOMMENDATIONS AND CONCLUSIONS

Based on the information compiled and reviewed in this report a number of recommendations for research and education needed to prevent workers' home contamination are identified in this Chapter. Also, a number of conclusions can be drawn from the report, as discussed below.

Recommendations for Research and Education

The prevalence of health effects of contaminants transported from the workplace need to be determined. One possible approach would be to conduct surveys among occupational and environmental medicine health care providers and clinics. Employment practices and controls that work best in preventing the transport of contaminants from the workplace to the home should be identified, and the special needs and problems of individuals who work in home or cottage industries need to be identified.

Educational programs to prevent home contamination should be developed for employers, workers, children, teachers, and parents, physicians, and other health professionals.

Conclusions

Workers' home contamination may pose a serious public health problem. Health effects and deaths from contaminants brought home from the workplace have been reported in 28 countries and 36 States. The extent to which these health effects occur is not known because there are no information systems to track them, and physicians do not always recognize the occupational contribution to various common diseases. About half of the reports of health effects from home contamination are less than 10 years old. The literature on the health effects involved approximately 30 different substances or agents. The potential exists for many of the thousands of other chemicals used in commerce to be transported to workers' homes or to be used in home-centered businesses.

Health effects and deaths from contaminants brought home from the workplace are preventable using known effective measures, however educational programs are needed to promote their use. Preventive measures are necessary because normal house cleaning and laundry practices are often inadequate for decontaminating workers' homes and clothing and can increase the hazard to the person performing the tasks and others in the household.

Only two Federal laws have elements that directly address workers' home contamination. However, other laws provide agencies with certain mechanisms for responding to, or preventing workers' home contamination. Under existing laws, OSHA, MSHA, DOE, ATSDR, EPA, and CDC, including NIOSH and the National Center for Environmental Health have responded to incidents of workers' home contamination, made preventive recommendations, and conducted relevant research.